IOOS - Customer-Focused Activities

Marcia Weaks
National Oceanic and Atmospheric Administration
Integrated Ocean Observing System (IOOS) Program Office
1100 Wayne Ave #1225, Silver Spring MD 20910 USA

Samuel Walker
Southeast Coastal Ocean Observing Regional Association
SECOORA Ocean Data Partnership
901 Sumter Street, Suite 702-G, Columbia, SC 29208 USA

Michael Koziara
National Oceanic and Atmospheric Administration
National Weather Service Weather Forecast Office
62300 Airport Road, Slidell, LA 70460 USA

Abstract - Integrated Ocean Observing System (IOOS) customer projects are designed to initiate, extend and adopt IOOS data management and communication, observing or modeling and analysis components to add value to customers and subsequently provide information about the value of an integrated ocean observing and modeling system that is coupled and managed as a system, rather than individual sources of data, models and information. The value and power of the Integrated Ocean Observing System (IOOS; http://ioos.noaa.gov/) is being realized in individual customer-focused projects such as one supporting NOAA's National Weather Service (NWS) operational storm surge and inundation forecasting, as well as in regional scale efforts such as near shore water quality monitoring, search and rescue, asset placement decisions, and educational opportunities coordinated by IOOS Regional Associations. These projects utilize integrated data and information in standard formats from multiple sources, and leverage the expertise and collaboration of various public, private and academic partners that are involved in implementing IOOS. In this paper, several customer projects will be described as successful examples of IOOS projects that illustrate the value of IOOS.

I. Introduction

The Integrated Ocean Observing System (IOOS) (http://ioos.gov) is being designed to support customer requirements for data and information on oceans and coasts through a robust network of operational observing activities which include data management, communication systems, modeling, analysis, training, outreach and education [1]. Customers range from coastal managers who make resource decisions to emergency managers and ship captains coming into port. Customer projects can be highly experimental such as demonstrating a new concept or technique, or providing a path to operational implementation of an agreed-upon protocol, standard or model. A common theme for all projects is serving customer needs for data, information, products and services through improved access/integration of data and model output via standardized interfaces and protocols. Having standards allows application developers to focus their efforts on product improvements and not on data reformatting and manipulation, a common feature of systems that are not well integrated. Also invaluable is close collaboration and communication among project partners during project development and implementation. Close partner collaboration with the focus on addressing customer requirements for data and information that meet performance and quality needs is critical to success. Lessons learned are documented and applied to decisions about expanding IOOS to serve additional customers and/or requirements of existing customers.

Specific initial customer efforts within the National Oceanic and Atmospheric Administration (NOAA) IOOS Program Office have focused on establishing a data integration framework that is designed to improve management and dissemination of seven core ocean variables in support of four NOAA models/decision-support tools and to establish standard data management/dissemination of coastal data at a regional scale. The data integration framework is also designed to be flexible and extensible to allow incorporation of additional variables, data sources, models/decision-support tools to be compatible and supportive of Federal Enterprise Architecture, the Global Earth Observing System of Systems and other existing integration and data management efforts. Additional details about the IOOS data integration framework and future efforts are found in [2].

0-933957-38-1 ©2009 MTS

In this paper, several customer-focused projects will be described to emphasize the value of utilizing integrated data and information in standard formats from multiple sources, and leveraging the expertise and collaboration of various IOOS public, private and academic partners. Projects were selected based on need, readiness of the partners and available resources, and expertise to achieve the project goals. Various means of assessing the value of the project to the customer were customized for each project. Initial results and findings are presented and will be complemented by final results in FY2010.

II. Examples of Customer Applications

A. Coastal Inundation

One of the customer projects targeting NOAA's models/decision support tools is the Sea Lake and Overland Surges from Hurricanes (SLOSH) Display Program (SDP) enhancement project that involves National Weather Service (NWS) and National Ocean Service (NOS) partners. The SLOSH model is the operational model used by NWS forecasters, emergency managers, Federal Emergency Management Administration (FEMA) and National Hurricane Center (NHC) to determine pressure and wind-driven surge from hurricanes. Surge information, along with local observations and knowledge of local effects, is critical for providing forecasts of flooding and is a crucial input in decisions made by emergency managers prior to and during storm events. The SDP is a graphical program that allows for display and animation of surge and static tide information.

Planning for the SDP enhancement project began late last year, with an operational roll out targeted for the 2009 hurricane season which began June 1, 2009. Operational NWS forecasters from the Slidell, LA.and Wakefield, VA. Weather Forecast Offices, along with storm surge specialists at the National Hurricane Center, provided key suggestions into plans and continuously tested and evaluated the SDP as it was being developed on a monthly basis. The SLOSH programmers from NWS's Meteorological Development Laboratory worked closely with tide experts and data base administrators from NOS's Center for Operational Oceanographic Products and Services to implement the IOOS data standards and web services to combine these data with surge information from SLOSH to maximize the information value to NWS.

As a result of the close collaboration between NOS and NWS, for the first time, a time series of NOS tide observations, predictions and winds, along with a time series of wind observations from NWS's National Data Buoy Center were available along with surge information on the same graphical display used by NWS forecasters. A new IOOS tool bar button allows NWS offices to display observed, predicted storm tide and wind direction, wind speed at user-selected NOS water level sites and NWS National Data Buoy Center CMAN observation platforms in real time via an internet connection (Fig. 1). Previously, NWS forecasters had to toggle between web sites on a separate screen to access the NOS tide information, and then manually combine the tide information with the surge information. The integration of this data into SDP should aid NWS when they brief emergency management officials during hurricane threats and when they compose local action statements for dissemination to the news media and public.

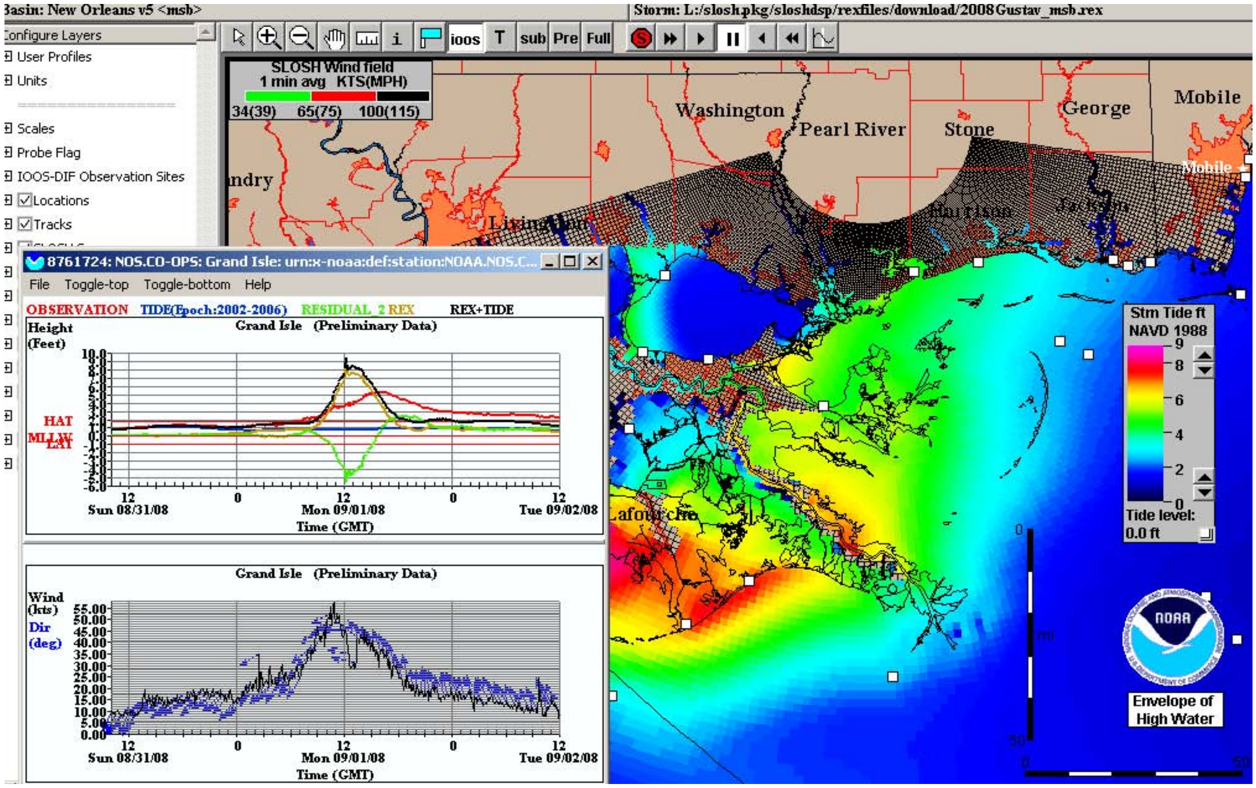

Fig. 1 New SLOSH Display for storm-induced surge with IOOS-derived observations of time series plots of observed and predicted water levels, wind speed and wind direction for Grand Isle, LA. during Hurricane Gustav in 2008.

Several additional enhancements were added to the SDP based on input for coastal NWS offices and the NHC for evaluation during 2009. These include the "sub" or subtract terrain option which allows storm surge to be displayed as height of surge above ground level in a SLOSH grid cell (Fig. 2). Previously, surge was displayed in feet as referenced in the National Geodetic Vertical Datum (NGVD) or Mean Lower Low Water (MLLW) datum with no explicit reference to ground elevation. This new capability allows the NWS greater flexibility in describing the storm surge threat in terms that coastal residents can more easily understand. For example, the SDP can display storm surge of 5 feet above average ground elevation of 10 feet for a specified coastal area. Previously, a 15 foot surge would have been used to describe the surge for the same area. This new capability removes confusion about ground elevation and datum for both the NWS and the public that became apparent when Hurricane Ike made landfall along the upper Texas coast in 2008.

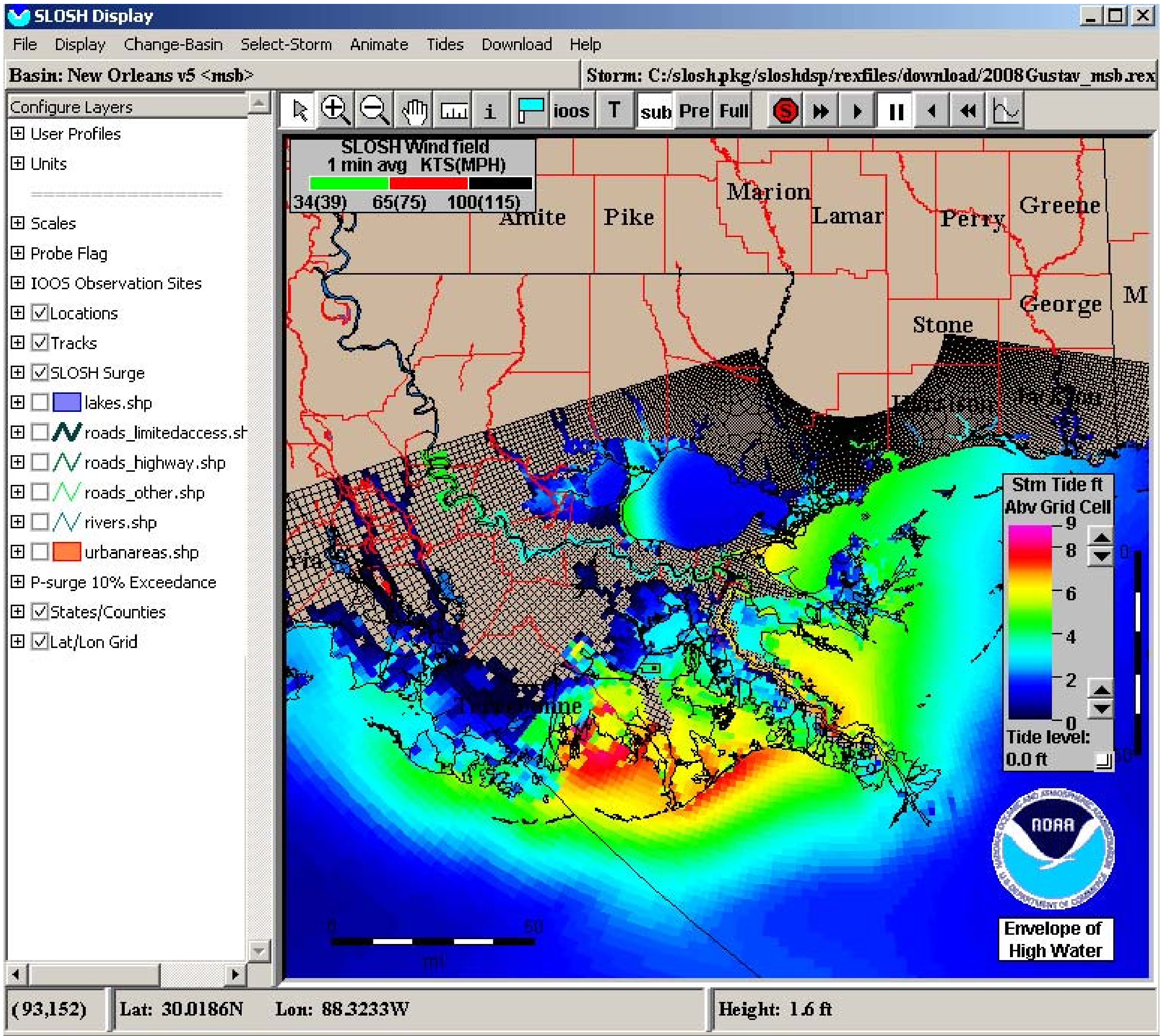

Fig. 2 Individual historical SLOSH run for Hurricane Gustav (2008) for the New Orleans basin displaying height above ground level.

Also now available are additional annotation and labeling display options in SDP which give the user more individual control over SDP include: (1) shapefiles which display roads, urban boundaries, rivers and lakes, and (2) ability to add text and change font size, color and line width for various parameters as shown in Fig. 3.

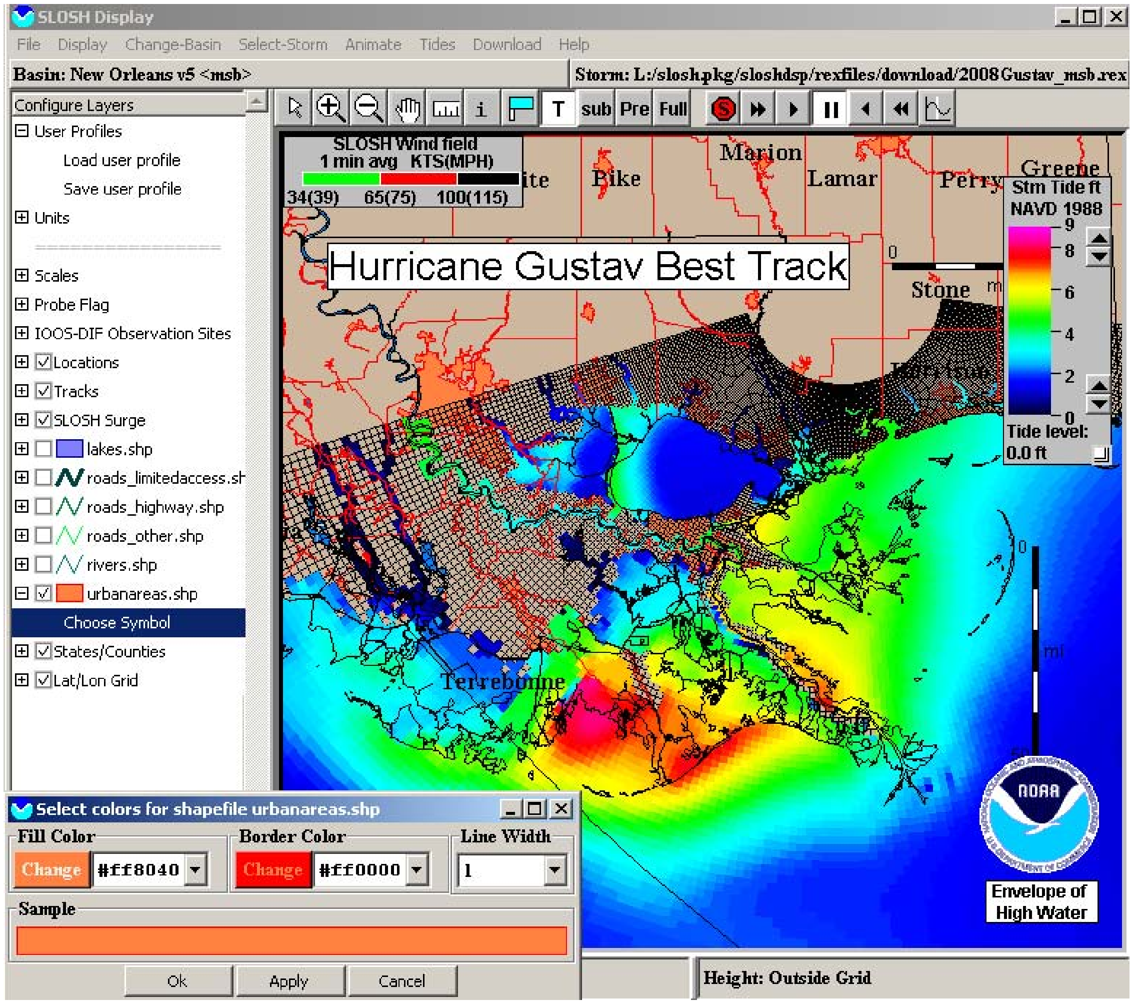

Fig. 3 New SDP text and font options

All these new features will help the WFOs and NHC make better use the SLOSH display for briefings to the media and emergency managers. Media and other briefings are a key element in NWS strategy to communicate critical information designed to reduce the loss of life and property, so efforts to simplify the information and motivate behavioral changes in the public are especially beneficial.

Forecasters are now poised to utilize the new SDP for this season's storm surge operation. An evaluation of the value of the project to both the NWS Forecast Offices and National Hurricane Center will be completed after the hurricane season ends in November, 2009. Performance metrics were developed as part of the project and will be provided as part of the assessment project report [3]. These metrics and corresponding measurement units are found in Table 1, below.

TABLE 1
METRICS FOR IOOS COASTAL INUNDATION PROJECT

Metric	Measurement Unit
Improved availability of real-time observations and tide predictions	Percentage improvement
Decrease of time required for data collection and processing for model initialization	Hours or percentage improvement
Presentation of real-time observation data, tide predictions, and statistics to the external audience through the season.	Number of events
Presentation of enhanced display to the external audience through the season	Number of events
Improvement in HLS forecast due to additional SLOSH Display data	Qualitative assessment
Improved communication with local emergency managers in pre-storm time frame	Qualitative assessment

B. Regional Customer Activities

Regional Associations (RAs) represent the interest of groups that depend on, manage, monitor and study marine systems in their respective regions. RAs engage representatives from federal and state agencies, private sector, nongovernmental organizations (NGOs), tribes and academia in the design, implementation, operation and improvement of regional coastal ocean observing, modeling and analysis capabilities. Within the Southeast Coastal Ocean Observing Regional Association (SECOORA) (http://www.secoora.org) region there is an increased focus on the use of storm surge/inundation model outputs to inform local evacuation planning and zoning. These data may also prove valuable to commercial sector interests, such as insurance firms and coastal developers. In addition, the region has been working collectively to identify how ocean observations can help inform key decision about the adoption and placement of offshore energy projects and assets. Key physical and biological data are required to evaluate optimal placement of wind turbines, drilling platforms, or submarine energy systems.

Recently, SECOORA began contributing regional high-frequency radar (HFR) data to the National HFR Network, thereby providing valuable information (via web services) to search and rescue agencies like the United States Coast Guard (USCG). These HFR data are also being distributed at the regional level to help with model validation, evaluate propagation of surface pollution transport and identify near shore hazards such as rip-currents [4]. These public health and safety applications demonstrate a clear benefit to local citizens, tourists, commercial and recreational boaters. Ongoing observations from coastal radar installations, buoys, remote sensing platforms, Autonomous Underwater Vehicles (AUVs), and other *in situ* platforms provide key decision-making data for recreational fishermen, boaters and public safety officials. They also contribute to model calibration and validation efforts, including the evaluation of ocean color and temperature grids developed from processed remote sensing data. These same data are being used to promote commerce through value-added products and services to fishermen and weather forecasters. Long-term ocean observations enable researchers to establish trends and develop models for Harmful Algal Bloom (HAB) prediction and tracking, such as those under development at the Center for Red Tide Prediction – a joint effort between the University of South Florida (USF) and the Florida Fish and Wildlife Research Institute (FWRI). Local health, environmental, and tourism officials can then use these outputs to make key decisions about beach and shellfish bed closures or advisories [5].

In order to effectively meet the requirements of these and a host of other regionally-relevant thematic projects, it is critical to maintain an efficient data and information management capability. Over the past decade, IOOS partners, including the Southeast region, have built a strong data management and communications (DMAC) capacity and knowledge base, enabling the integration of ocean observations at a national and regional scale. By adopting a service oriented approach to data dissemination, federal, state, local agencies, SECOORA and other Regional Associations, have enabled interoperability of core IOOS variables such as water temperature, salinity, and surface currents. This permits the development of applications that span regional borders, or require data beyond the extent of specific observing platforms (e.g., shore-based high-frequency radar systems). New open source technologies and on-line mapping tools further enable our ability to quickly and efficiently reach user groups and aid decision-making processes (see Fig. 4). Maintaining a current and accurate regional asset inventory that includes physical observing assets, data management components, virtual elements, and database/archive resources also helps with application development by informing users about the availability of data sets (see Fig. 5).

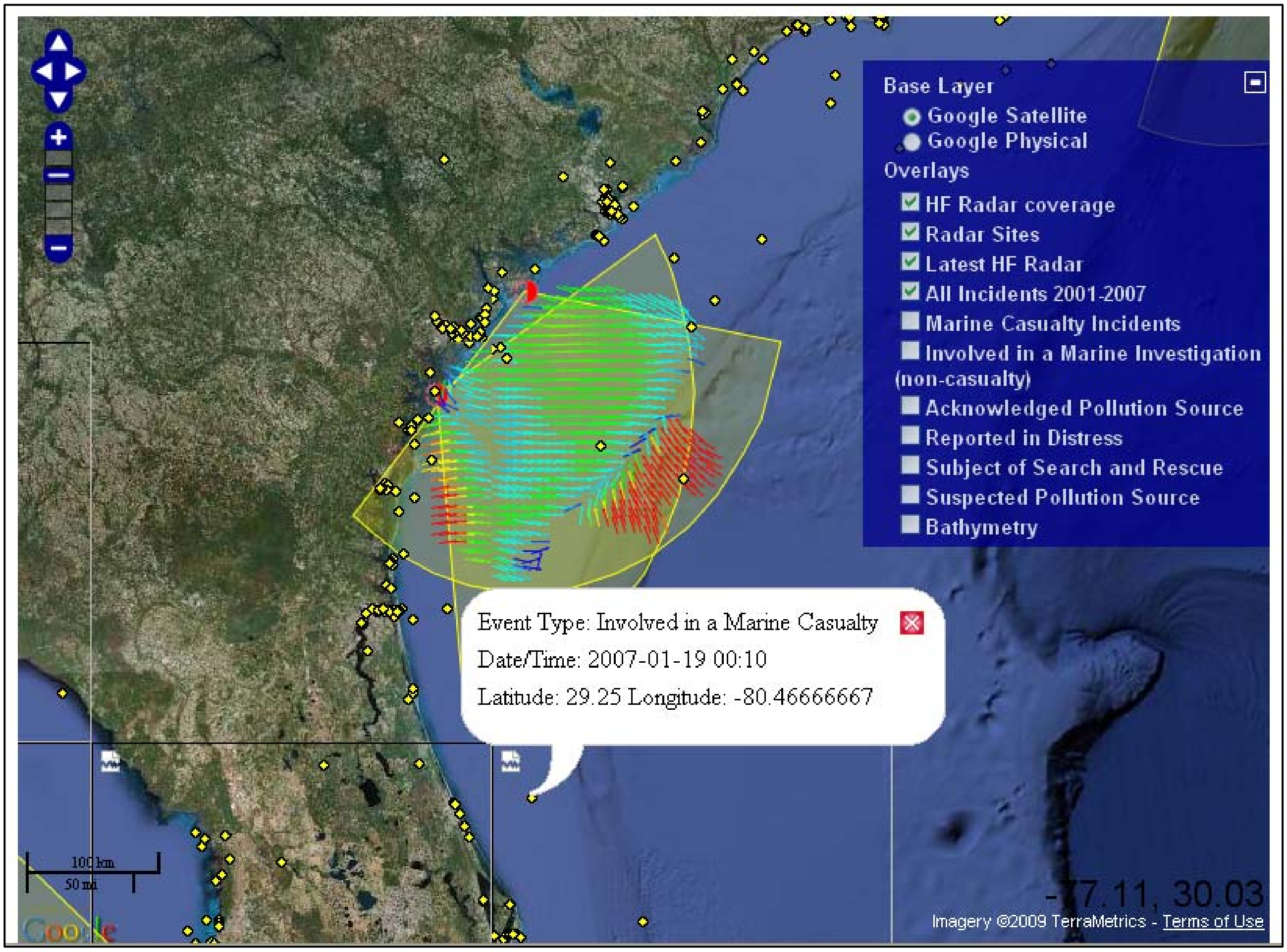

Fig. 4 Example map overlay of HF Radar coverage and historical USCG marine incident data. Regional applications of this type can be used to prioritize observing asset deployments, maintain safer marine operations, and assist with informing stakeholders about IOOS capabilities. (Map Developed by Dan Ramage, USC and Sam Walker, SECOORA; Image Source: Google).

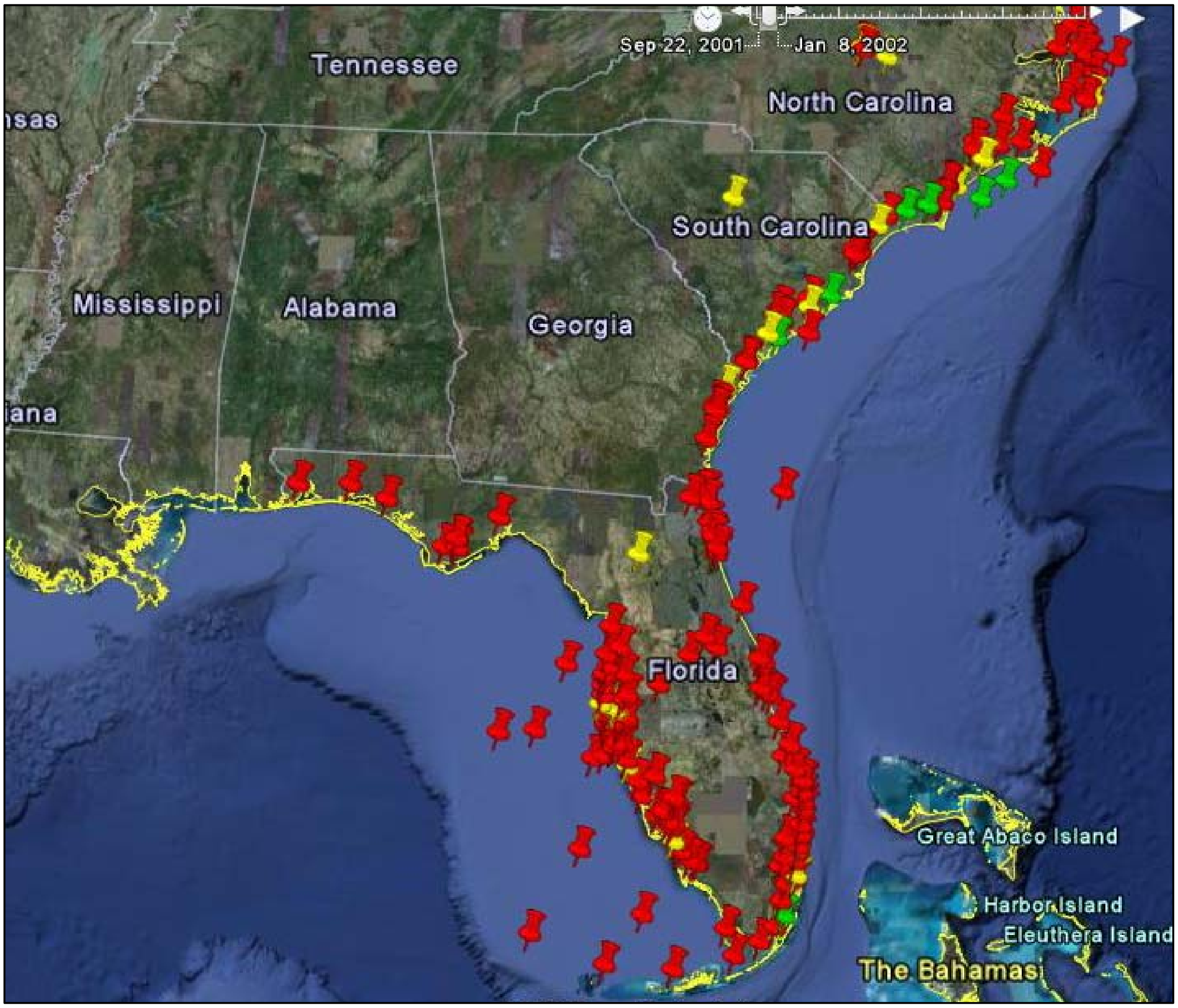

Fig. 5 Regional representation of observing assets in the Southeast including the location of buoys, gliders, remote sensing downlink stations, DMAC hubs, virtual modeling grid centers, and HF radar stations. (Map Developed by SECOORA; background image and symbology by Google).

Effective facilitation of regional observing activities requires an acknowledgement of previous and ongoing sub-regional efforts. The Southeast region has been fortunate to host numerous coastal ocean observing projects in recent years. A variety of projects, including Coastal Ocean Monitoring and Prediction System (COMPS), Coastal Ocean Research and Monitoring Program (COMRP), Tampa Bay Physical Oceanographic Real-Time System (PORTS), Carolinas Coastal Ocean Observing and Prediction System (Cara-COOPS), and Southeast Atlantic Coastal Ocean Observing System (SEACOOS) (among others) have produced a wide range of regional products and skilled ocean observing professionals in the region [6]. More recently there have been several other IOOS-supported efforts (beyond SECOORA's own direct efforts) in the Southeast including a Regional Storm Surge and Inundation Model Test Bed, the Carolinas RCOOS project, a Prototype Operational Modeling System for Waves, Coastal Currents, Inundation, and Hydrologic Flooding for Eastern North Carolina, and the expansion of the Marine Weather Portal (details available at http://ioos.gov/library/regionalfactsheets_2008.pdf). All of these projects have resulted in numerous stakeholder engagement opportunities (e.g., workshops, meetings, demonstrations, symposia) that enable clear identification of regional user needs and interests. SECOORA helps facilitate intra-regional collaboration to more effectively leverage existing assets and reach a broader constituency.

A challenge that remains at the regional level is maintaining a balance between numerous stakeholder requirements. With all major sectors (private, non-profit, academic, and government) involved in the regional associations there is a need to establish clear roles for each group and identify available resources to address specific needs. With interests ranging from port safety and efficiency to recreational fishing and alternative energy production there are some obvious applications of coastal ocean observing data. Galvanizing support and building a reputation as a valuable and reliable regional enterprise will require continued stakeholder engagement, the ability to clearly define outcomes, and an enhanced capacity to broadcast the results.

III. SUMMARY

Satisfying customer requirements for ocean data and information through an effective system that links ocean observations to modeling through an integrated data management and communication is the crucial goal for IOOS. The NOAA IOOS Program is working with federal, state, private sector, academic and regional partners such as those mentioned above to accomplish this goal. Initial efforts to build an integrated system has begun through a series of customer projects described above, along with other existing and planned projects with IOOS partners and regions. Results from customer projects will be assessed and lessons learned will be reviewed and utilized in planning, evolving and expanding the IOOS system. Results from current customer projects will be documented and made available on the IOOS web site http://ioos.gov.

AKNOWLEDGEMENT

Marcia Weaks of the IOOS Program Office sincerely thanks the collaboration and teamwork of the coastal inundation partners Mike Koziara, Frank Revitte, Tony Siebers, Bill Sammler, Jamie Rhome and the NHC Storm Surge Team, Arthur Taylor, Lori Fenstermacher and Andrea Hardy, and the Regional Association representatives such as Sam Walker for helping to make IOOS a national system that adds value to a wide variety of customer needs.

REFERENCES

[1] "The First U.S. Integrated Ocean Observing System (IOOS) Development Plan", The National Office for Integrated and Sustained Ocean Observations, Ocean.US Publication No. 9, January 2006.

[2] J. de La Beaujardiere, "IOOS Data Management Activities," in Proc. MTS/IEEE Oceans 2009 Conf, IEEE Marine Technical Society, paper #090529-023 (this volume), September 2009.

[3] "Data Integration Framework Customer Implementation Project Summary and Performance Assessment Plan", NOAA IOOS Program Office, August 2009.

[4] Liu, Y., R.H. Weisberg, C.R. Merz, S. Lichtenwalner, and G.J. Kirkpatrick, 2009: HF radar performance in a low energy environment: CODAR SeaSonde experience on the West Florida Shelf. *Journal of Atmospheric and Oceanic Technology* (submitted & revised).

[5] Hu, C. (2009). "A novel ocean color index to detect floating algae in the global oceans." Remote Sens. Environ. 113:2118-2129.

[6] "Global Lessons Learned from Regional Coastal Ocean Observing Systems" 2008. Marine Technology Society Journal, Volume 42(3)